Physics 11 Work, Mechanical Advantage and Efficiency

Name__________________block________

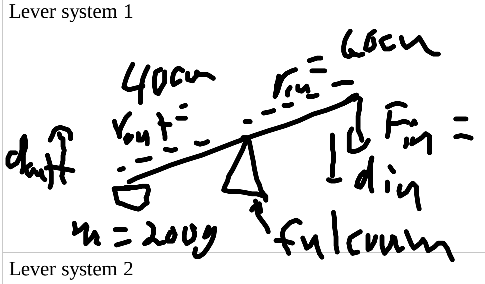
Purpose: determine the mechanical advantage and efficiency of 2 pulley systems and 2 levers.

Theory: Work = Force x distance in Joules
Mechanical Advantage = Fout/Fin Ideal MA = Din/ Dout No units
efficiency = Wout/Win x 100% in %

Procedure:

- Setup a pulley system or a lever to lift a mass, draw the setup in the space below.
- Measure the Fin, Din, Dout, and record the masses to calculate the Fout by F=mg.
- Determine the Ideal meachanical advantage by IMA = Din/Dout
- Calculate the mechanical advantage MA=Fout/Fin
- Determine the efficiency = Wout/Win x 100% = FoutDout/FinDin x 100%
- Compare the efficiency to the percentage uncertainty of your most imprecise measurement. For example, if your force is 1.2 N +/- 0.2N that is 0.2/1.2 x 100% = 17% uncertainty.

Table continued on back

Drawings - include predicted Fin	data	IMA calc	MA calc	Efficiency calc
Lever system 1 	Fin ______ Din _______ Dout ______ Hanging Mass ______ 200g = 0.2kg Mass of moving pulleys or metre stick ________ Calculate Fout ____ 0.2kg x 9.8N/kg = 2N	Din/Dout 6cm/4cm = 1.5	Fout/Fin 2N/1.5N 1.3	(Fout x dout)/(Fin din) = (2N x 0.04m)/(1.5N x 0.06m) = 89%
Lever system 2	Fin ______ Din _______ Dout ______ Hanging Mass ______ Mass of moving pulleys or metre stick ________ Calculate Fout ____________			
Drawings	data	IMA calc	MA calc	Efficiency calc
Pulley system 1	Fin ______ Din _______ Dout ______ Hanging Mass ______ Mass of moving pulleys or metre stick ________ Calculate Fout ____________			
Pulley system 2	Fin ______ Din _______ Dout ______ Hanging Mass ______ Mass of moving pulleys or metre stick ________ Calculate Fout ____________			

% uncertainty of your least precise measurement =

Were any machines were more efficient than the uncertainty? Why/why not?

Were any machines were more efficient than the uncertainty? Why/why not?

reading Force value

if $\pm$ 0.5N estimate

$\frac{0.5N}{1.5N}$ = 33% Uncertainty

100% - 89% = 11% is smaller than 33%, so it is within uncertainty

Energy (Chapter 11)
Quiz Jan 17th Work and Energy
Test Jan 25th Momentum, work and energy

Reminder
Work is force through a displacement.

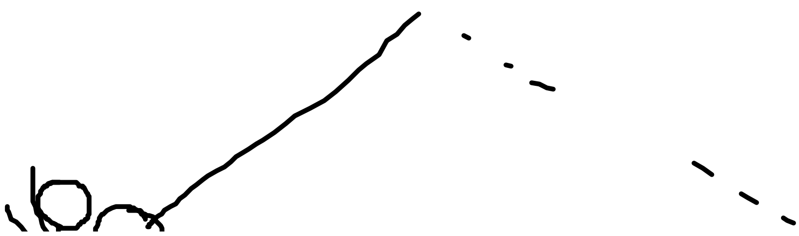
W=Fd if F is in the direction of d,
=0 if F is perpendicular to d
units: Joule, J=Nm

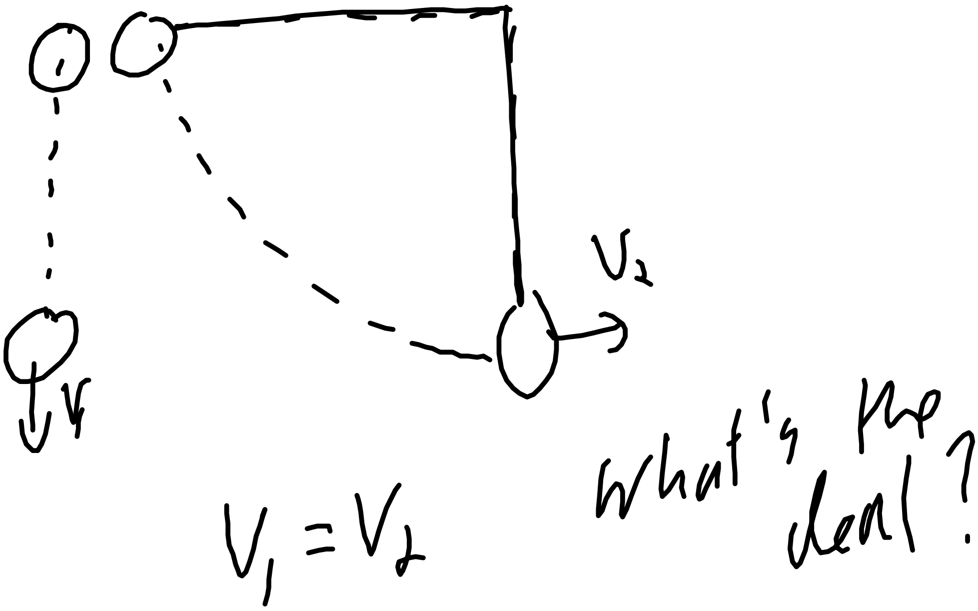
Work is equal to the change in energy.
W=Δenergy

Energy is the ability to do work.
Energy is conserved - changes form.

What are different forms of energy?
electric energy
kinetic energy, E_k (energy of moving objects)
Thermal Energy, U - Heat is the transfer of thermal energy, Q
Potential energy - term for stored energy - try to use more precise terms.
chemical energy
Gravitational energy, E_g, energy due to the gravitational pull.
Nuclear energy - weak nuclear energy - beta decay and strong nuclear energy - fusion/fission
light and magnetism
elastic energy

Let's look at Gravitational energy and Kinetic Energy
https://www.youtube.com/watch?v=7zy-zfLB4jI
https://www.youtube.com/watch?v=BVxEEn3w688&feature=fvw
http://techtv.mit.edu/videos/1491-potential-energy-to-kinetic-energy





Energy is conserved. You start with a certain amount of gravitational energy that gets transformed into kinetic energy. If no energy is lost, the end kinetic energy is the same regardless of the path - straight down or swing arc.

Derive equations time:
Basic idea is W=Δenergy
Look at gravitational energy, E_g
When you lift something, you are doing work against gravity.
$W_g=\Delta E_g = F_g d = mgd = mg\Delta h$

against gravity:

$W_g = \Delta E_g = F_g d = mgd = mg\Delta h$

$E_g = mgh$

Kinetic Energy, E_k

What causes changes in motion?

The net force, so

$W_{net} = \Delta E_k = F_{net}d = mad$

from kinematics $2ad = v_f^2 - v_i^2$

so $ad = \frac{1}{2}(v_f^2 - v_i^2)$

$W_{net} = \Delta E_k = m \frac{1}{2}(v_f^2 - v_i^2) = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$E_k = \frac{1}{2}mv^2$

eg. If a 50.0 g ball is dropped from a height of 0.400 m

a) what is the initial gravitational energy of the ball?

$E_g = mgh = 0.050\text{kg} \times 9.80\text{N/kg} \times 0.400\text{m}$

$0.050 \times 9.8 \times 0.4 = 0.196\text{ J}$

b) using $2ad + v_i^2 = v_f^2$ calculate the speed of the ball just before it hits the ground. $v_i = 0$

$\text{sqrt}(2 \times (9.8) \times (0.4)) = 2.80\text{ m/s}$

c) calculate the kinetic energy of the ball given your answer from b. How does it compare to your answer from a?

$E_k = 0.5 \times (0.05) \times (2.8) \times (2.8) = 0.196\text{ J}$

same as a!! coincidence? I think not.

d) Therefore, what is the speed of the ball if it swings through an arc from the same height?

same, 2.80 m/s assuming no energy lost in air resistance or frictional forces

p221-226 practice problems 1-8, concept review 1.1-1.5

10 minutes then go over the board questions

next class, students will give concept review answers